



C3808

Log Data Report

Borehole Information:

Borehole: C3808		Site: 216-Z-11 Ditch			
Coordinates (WA State Plane)		GWL¹ (ft):	66.8 m (219.29 ft)	GWL Date:	5/26/02
North	East	Drill Date	Elevation	Total Depth (ft)	Type
134981.76 m	566610.06 m	4/22/02- 5/28/02	204.43 m (670.70 ft)	68.7 m (225.25 ft)	Cable tool

Casing Information:

Casing Type	Stickup (ft)	Outer Diameter (in.)	Inside Diameter (in.)	Thickness (in.)	Top (ft)	Bottom (ft)
Log Event A (04/30/02)						
Steel threaded	1.15	11.75	10.75	0.5	1.15	20
Log Event B (05/02/02)						
Steel threaded	1.15	11.75	10.75	0.5	1.15	20
Steel threaded	1.65	8.625	7.625	0.5	1.65	30
Log Event C (05/20/02 – 05/21/02)						
Steel threaded	1.15	11.75	10.75	0.5	1.15	20
Steel threaded	1.65	8.625	7.625	0.5	1.65	30
Steel threaded	1.55	7.0	6.0	0.5	1.55	220.3

Borehole Notes:

Borehole C3808 was drilled to investigate subsurface conditions and to obtain samples associated with the 216-Z-11 Ditch. The borehole location was determined on the basis of data collected from shallow measurements made in GeoProbe holes. The drilling plan called for three telescoping casing strings to prevent dragdown of surface contamination. Logs were run between each change in casing diameter.

The ground surface surrounding this borehole has been built up and leveled with 1 to 2 ft of coarse gravel to support the drilling equipment. After logging, BHI will pull the casing, grout the borehole, and abandon the location. Casing size and depth information were provided by BHI field personnel. The logging engineer measured casing stickup using a steel tape. Zero reference is the top of ground surface.

On 4/26/02, the inside of the casing was swabbed by an RCT, and no contamination was detected. On 4/29/02 (Log Event A), the inside of the borehole was posted as a radiological contamination area (RCA). On 05/02/02 (Log Event B), the area around the borehole was posted as a radiological buffer area (RBA). On 05/20/02 (Log Event C), radiological postings had been removed.

Logging Equipment Information:

Logging System:	Gamma 2A	Type:	SGLS (35%)
Calibration Date:	11/01	Calibration Reference:	GJO-2002-286-TAR
		Logging Procedure:	MAC-HGLP 1.6.5, Rev. 0

Logging Equipment Information (con't.):

Logging System:	Gamma 2A	Type:	NMLS (35%)
Calibration Date:	11/01	Calibration Reference:	GJO-2002-291-TAR
		Logging Procedure:	MAC-HGLP 1.6.5, Rev. 0

Spectral Gamma Logging System (SGLS) Log Run Information:

Log Run	1	2	3	4	5
Date	04/29/02	04/29/02	05/02/02	05/02/02	05/20/02
Logging Engineer	Spatz	Spatz	Spatz	Spatz	Spatz
Start Depth (ft)	0	12.0	20.0	22.0	223.0
Finish Depth (ft)	21.5	4.0	30.0	27.0	94.0
Count Time (sec)	200	400	200	200	200
Live/Real	L	R	L	L	R
Shield (Y/N)	N/A ²	N/A	N/A	N/A	N/A
MSA Interval (ft)	0.5	0.25	0.5	0.5	1.0
ft/min	N/A	N/A	N/A	N/A	N/A
Pre-Verification	BA139CAB	BA139CAB	BA142CAB	BA142CAB	BA155CAB
Start File	BA139000	BA139044	BA142000	BA142021	BA155000
Finish File	BA139043	BA139076	BA142020	BA142031	BA155129
Post-Verification	BA139CAA	BA139CAA	BA142CAA	BA142CAA	BA155CAA

Log Run	6	7			
Date	05/21/02	05/21/02			
Logging Engineer	Spatz	Spatz			
Start Depth (ft)	29.0	131.0			
Finish Depth (ft)	95.0	150.0			
Count Time (sec)	200	200			
Live/Real	R	R			
Shield (Y/N)	N/A	N/A			
MSA Interval (ft)	1.0	1.0			
ft/min	N/A	N/A			
Pre-Verification	BA156CAB	BA156CAB			
Start File	BA156000	BA156067			
Finish File	BA156066	BA156086			
Post-Verification	BA156CAA	BA156CAA			

Neutron Moisture Logging System (NMLS) Log Run Information:

Log Run	1	2	3	4	5
Date	04/30/02	04/30/02	05/02/02	05/02/02	05/21/02
Logging Engineer	Spatz	Spatz	Spatz	Spatz	Spatz
Start Depth (ft)	0	21.25	20.0	30.0	29.0
Finish Depth (ft)	21.25	3.5	30.0	25.0	142.0
Count Time (sec)	15	15	15	15	15
Live/Real	L	L	L	L	R
Shield (Y/N)	N/A	N/A	N/A	N/A	N/A
MSA Interval (ft)	0.25	0.25	0.25	0.25	0.25
ft/min	N/A	N/A	N/A	N/A	N/A
Pre-Verification	BF000CAB	BF000CAB	BF001CAB	BF001CAB	BF002CAB
Start File	BF000000	BF000086	BF001000	BF001041	BF002000
Finish File	BF000085	BF000157	BF001040	BF001061	BF002452
Post-Verification	BF000CAA	BF000CAA	BF001CAA	BF001CAA	BF002CAA

Log Run	6	7			
Date	05/22/02	05/22/02			
Logging Engineer	Spatz	Spatz			
Start Depth (ft)	123.0	142.25			
Finish Depth (ft)	142.0	221.0			
Count Time (sec)	15	15			
Live/Real	R	R			
Shield (Y/N)	N/A	N/A			
MSA Interval (ft)	0.25	0.25			
ft/min	N/A	N/A			
Pre-Verification	BF003CAB	BF003CAB			
Start File	BF003000	BF003077			
Finish File	BF003076	BF003392			
Post-Verification	BF003CAA	BF003CAA			

Logging Operation Notes:

Pre- and post-survey verification measurements were acquired in the Amersham KUTh verifier SN 082.

The log reference is ground surface (elevation 670.7 ft).

On 04/29/02, during logging, the sonde was inside a plastic bag with a centralizer installed on the outside. (The plastic bag was not used on subsequent log events.) Access for logging is through the roof of a tent structure surrounding the borehole. The crane's leg supports are too short for this type of set up. A sling was attached to the drill rig's mast and the end of the crane for support.

On 04/29/02, log data from the initial log run were processed in the field to generate preliminary logs from which a suitable interval could be selected for more detailed investigation. As a result of the field log, the interval from 4 to 12 ft was re-logged with a count time of 400 sec and a depth increment of 0.25 ft to better delineate and quantify the relatively thin zone of contamination at the bottom of the trench.

On 05/02/02 and 5/20/02, a centralizer was installed on the sonde.

On 04/29/02, fine-gain adjustments were made after files BA139043 and -060. On 05/02/02, no fine-gain adjustments were made. On 05/20/02, fine-gain adjustments were made after files BA155069, -105, and -125.

SGLS repeat sections were run from 4 to 12 ft (Log Event A), 22 to 27 ft, (Log Event B), and 131 to 150 ft (Log Event C). NMLS repeat sections were run from 3.5 to 21.25 ft (Log Event A), 25 to 30 ft (Log Event B), and 123 to 142 ft (Log Event C).

Analysis Notes:

Analyst:	McCain	Date:	6/17/02	Reference:	MAC-HGLP 1.6.3, Rev. 0
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Pre-run and post-run verification spectra were collected at the beginning and end of each logging day. Evaluation of verification spectra indicated that the peak counts per second and peak width (fwhm) for the 609-, 1461-, and 2615-keV peaks fell within acceptance criteria for Gamma 2A, with the exception of BA139CAA and BA155CAA. On BA139CAA, the peak counts per second for the 2615-keV peak was within the control limits, but it exhibited a 10.2-percent decrease from the corresponding pre-run measurement. Verification criteria require that the post-run value for peak counts per second must be within 10 percent of the post-run value. The spectrum was carefully examined and no evidence of system malfunction was observed; therefore, the verification spectrum is provisionally accepted. On BA155CAA, the peak width values for the 1461- and 2615-keV peaks exceeded the upper control limits. In both cases, peak count rate was well within the verification criteria. Evaluation of the spectrum indicated a limited

amount of peak broadening, but this does not appear to affect count rates, and the spectrum is provisionally accepted.

The log data for this borehole were collected on three separate days, logging in three separate casing configurations, as the borehole was “telescoped” to seal off contamination. All three casing strings had a nominal thickness of 0.5 in. Except for minor overlaps at the upper portions of log intervals, all log data were collected through a single casing thickness, and a casing correction factor for 0.5-in. casing is uniformly applied to all data.

Spectra collected during each log run were processed in batch mode using APTEC Supervisor to identify individual energy peaks and to determine count rates. Concentrations were calculated with EXCEL using an efficiency function and corrections for casing as appropriate. No water correction was required. Maximum dead time was less than 1 percent; therefore, no dead time correction was required.

The routine analysis approach was modified to enhance sensitivity to ^{239}Pu and ^{241}Am . In addition to the peak search, regions of interest were “forced” for the major gamma lines associated with ^{239}Pu , ^{237}Np , and ^{241}Am . As a result, net counts greater than the minimum detectable activity were reported for the 375-keV peak in spectrum BA155062 (161 ft), and for the 662-keV peak in spectrum BA155123 (100 ft). Examination of the spectra indicated that these peaks were not credible and the data points were deleted from the plot.

Results from preliminary gamma energy analysis of samples indicated the presence of ^{239}Pu and ^{241}Am . However, the casing was too thick to allow the primary ^{241}Am gamma ray at 59.54 keV to be detected. A gamma peak at 662 keV was detected through the interval in which the sample analysis indicates ^{241}Am . This could represent a low-intensity gamma ray from ^{241}Am , or ^{137}Cs , a widely distributed contaminant at the Hanford Site. For ^{137}Cs , there are no other confirming lines, and other lines associated with ^{241}Am were not detected. Hence, it is not possible to discriminate between ^{241}Am and ^{137}Cs on the basis of the spectral gamma data. The absence of the primary ^{241}Am line at 60 keV is most likely a result of attenuation in the steel casing and suggests that the casing correction function should not be extrapolated to energies significantly lower than 180 keV. Analysis of the 662-keV line was carried out for both ^{241}Am and ^{137}Cs .

Radionuclide concentrations are calculated on the assumption of a uniform distribution symmetric about the borehole axis and infinite in vertical extent. They should be considered “apparent concentrations” because the actual distribution may be significantly different. In the case of thin beds, the true radionuclide concentration within the bed may be significantly higher, because the detector responds to the average concentration over a vertical extent of about a foot.

The neutron moisture log is plotted as total counts over the entire borehole. For the borehole interval between 20 and 30 ft, the calibration equation for an 8-in. borehole is used to estimate moisture content. For the borehole interval below 30 ft, the calibration equation for a 6-in.-diameter borehole is used to estimate moisture content. Neutron log response is very sensitive to borehole diameter, and the neutron log in the upper 20 ft should be viewed as only qualitative.

Log Plot Notes:

Separate log plots are provided for the man-made radionuclides (^{239}Pu , ^{241}Am , and ^{137}Cs) detected in the borehole, naturally occurring radionuclides (^{40}K , ^{238}U , ^{232}Th [KUT]), a combination of man-made, KUT, total gamma, and neutron moisture log. Because the 662-keV line could be associated with either ^{137}Cs or ^{241}Am , log plots are provided for both radionuclides.

Because the contaminated zone is so thin, log plots were generated to show net counts for specific gamma lines. Open symbols indicate the minimum detectable activity (MDA) for each gamma line. Plots are also prepared to show estimated radionuclide concentrations in picocuries per gram. The 662-keV line is used to determine both ^{241}Am and ^{137}Cs . Error bars on each plot represent error associated with counting

statistics only and do not include errors associated with the inverse efficiency function, dead time correction, casing corrections, or water corrections. These errors are discussed in the calibration report.

Neutron logs are plotted as both total counts and as volumetric moisture content where borehole diameter is close to the calibration diameter.

For each repeat section, log plots of the 609-, 1461-, 1764-, and 2615-keV gamma lines are provided, as well as plots of neutron log response in counts per second. Except where affected by radon, the repeat logs agree well with the original log data.

Results and Interpretations:

^{239}Pu was the primary man-made contaminant detected in this borehole. ^{239}Pu was identified from the presence of gamma rays at 129, 375, and 414 keV. The maximum concentration of about 2.14 E-4 pCi/g (21.4 nCi/g) occurs in a thin bed (thickness of approximately 3 in. or less) at a log depth of 9.5 ft. No effort is made to correct for thin bed effects; the actual concentration within the contaminated bed may be significantly higher, because the log represents an averaged response over a depth interval of approximately 1 ft. The minimum detection limit (MDL) for ^{239}Pu is about 18 to 24 nCi/g for the 200-s count time and about 10-18 nCi/g for the 400-s count time.

Preliminary results of gamma energy analysis on soil samples indicate the presence of ^{241}Am in the borehole interval above 20 ft. However, the primary gamma line for ^{241}Am at 59.54 keV was not detected, which appears to be the result of attenuation in the 0.5-in. steel casing. A 662-keV peak is encountered at 4.25 to 5.75 ft and 7.5 to 10.25 ft. Typically, this peak would be attributed to ^{137}Cs . If it is assumed to be ^{137}Cs , the maximum concentration is approximately 0.55 pCi/g at 9.5 ft. However, it may also be a low-intensity gamma line for ^{241}Am (662.4-keV, yield 3.64 E-6 gammas per decay). If the peak is attributed to ^{241}Am , then the maximum concentration at 9.5 ft is about 1.28 E-5 pCi/g (128 nCi/g). In the case of ^{241}Am , other low-intensity gamma lines should confirm the identification. For example, lines at 335.37 keV (4.96 E-6 gammas per decay), 368.05 (2.17 E-6 gammas per decay), and 722.01 (1.96 E-6 gammas per decay) should also be present. However, these gamma rays are not detected. The most credible explanation for the observed spectral response is that the 662-keV peak represents a mixture of ^{137}Cs (possibly as a result of atmospheric fallout from nuclear tests unrelated to Hanford) and ^{241}Am . In this case, the values shown on the log plots for ^{137}Cs and ^{241}Am represent upper bound estimates, because both are calculated from total net counts.

Evaluation of the KUT, total gamma, and neutron logs provides information regarding stratigraphic variations. At a depth of approximately 10 ft, abrupt increases in ^{40}K and ^{232}Th concentration indicate the probable bottom of the excavation. An increase in neutron count rate between 11 and 13 ft may indicate increased moisture just below this contact. The logs indicate that the contaminated layer occurs just above this interval.

Increases in ^{232}Th concentration and neutron log response indicate probable zones of finer material from 40 to 43 ft, 64 to 69 ft, 75 to 77 ft, 97 to 98 ft, and 110 to 114 ft. Between 121 and 142 ft, the neutron log indicates a thinly bedded sequence with higher moisture content that is interpreted as the Plio-Pleistocene unit. Between 142 and 144 ft, a significant increase in ^{238}U concentration is accompanied by decreases in ^{40}K and ^{232}Th concentrations. This distinct signature, which represents the caliche layer above the Ringold Formation, is widely observed in the 200 West Area. Increases in ^{40}K and ^{232}Th concentrations from 185 to 202 ft suggest a higher silt content. However, the neutron log response in this interval declines slightly, suggesting the material is probably a silty gravel layer.

Increases in ^{238}U concentration from 4 to 20 ft and from 20 to 30 ft appear to be the result of radon in the borehole. Quantification of ^{238}U is based on gamma rays associated with the daughters ^{214}Bi and ^{214}Pb , which are also short-term daughters of ^{222}Rn . This is especially evident between 4 and 12 ft, where the ^{238}U concentration in the original log run was between about 0.7 and 1.1 pCi/g in the initial run and between about 1.3 and 1.5 pCi/g in the subsequent run. The presence of radon is typically indicated by a

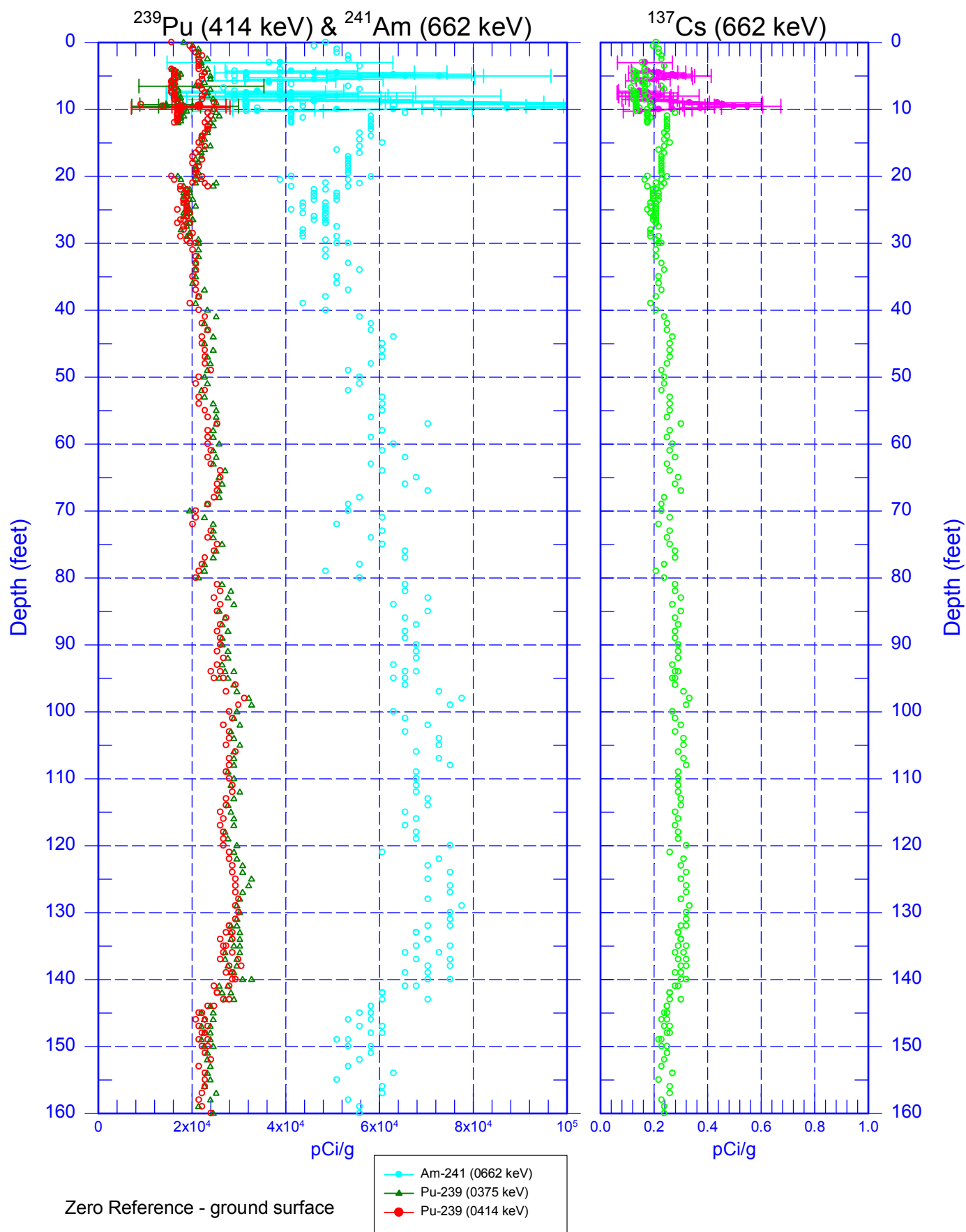
discrepancy between ^{238}U concentrations calculated from the 609-keV gamma ray and ^{238}U concentrations calculated from the 1764-keV gamma ray, because the casing correction factor decreases with increasing energy. Because the radon daughters are inside the casing, they are not attenuated, and the effect of the casing correction factor is to increase the apparent concentration from the 609-keV peak relative to the 1764-keV peak.

¹ GWL – groundwater level

² N/A – not applicable

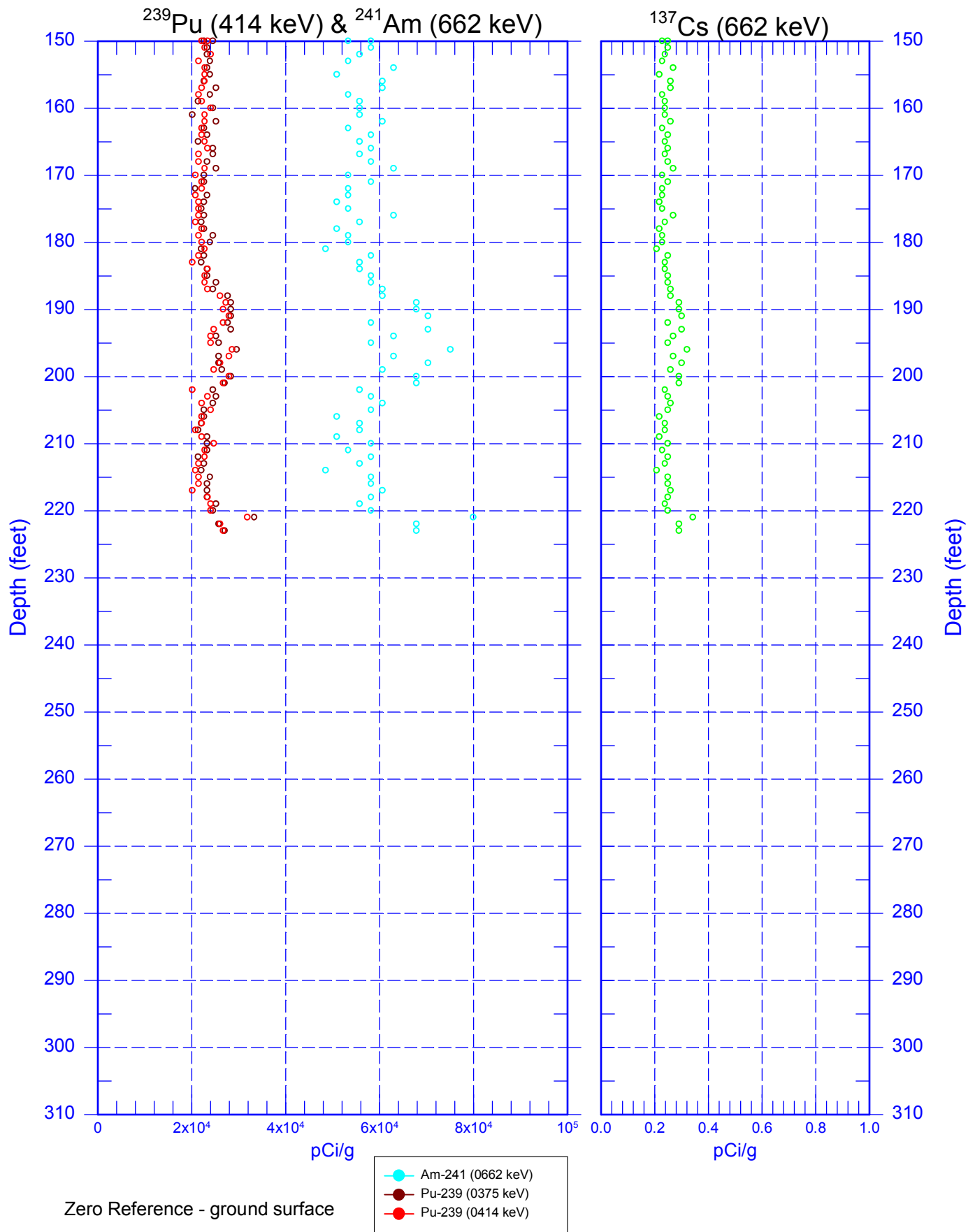
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Man-Made Radionuclides



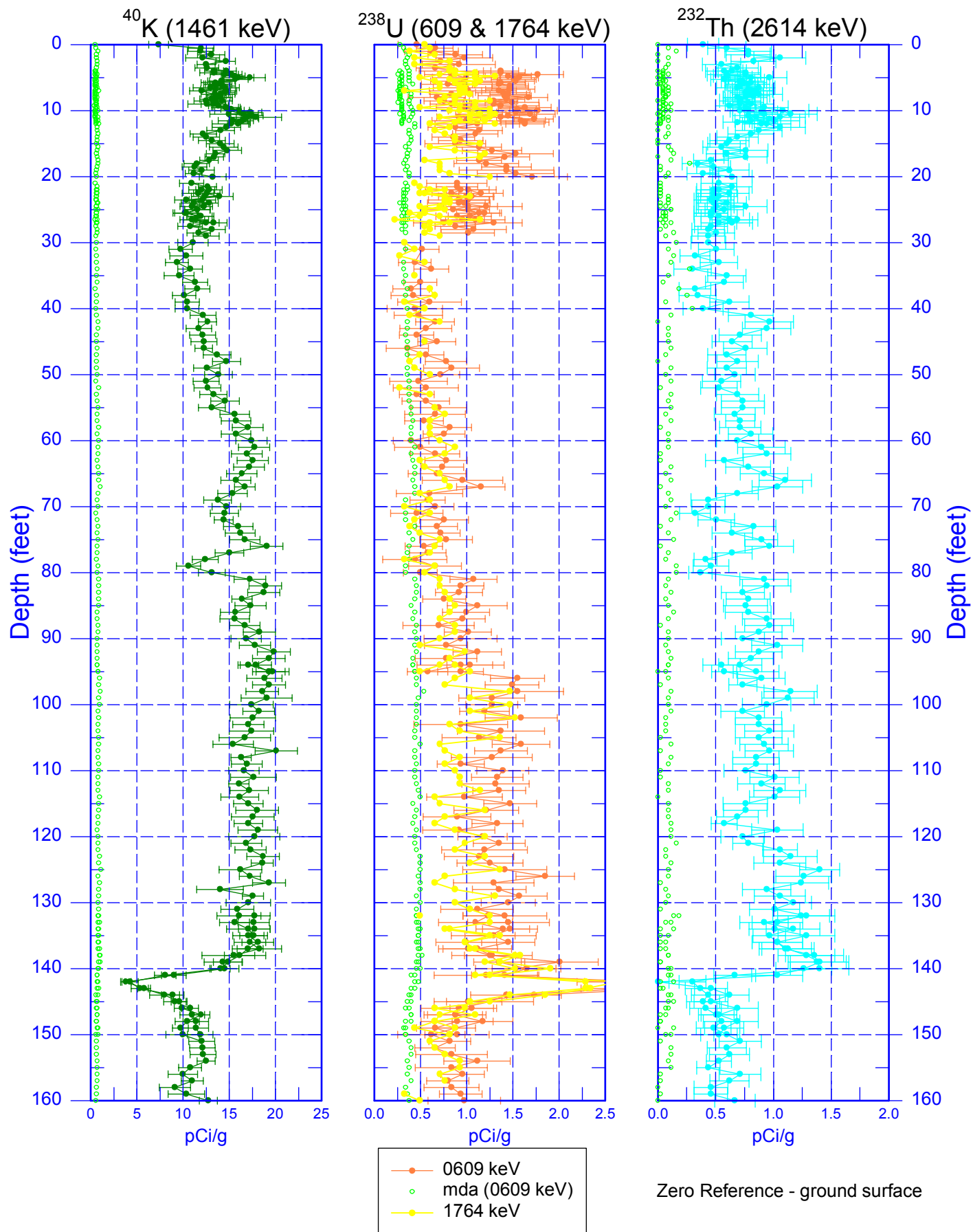
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Man-Made Radionuclides



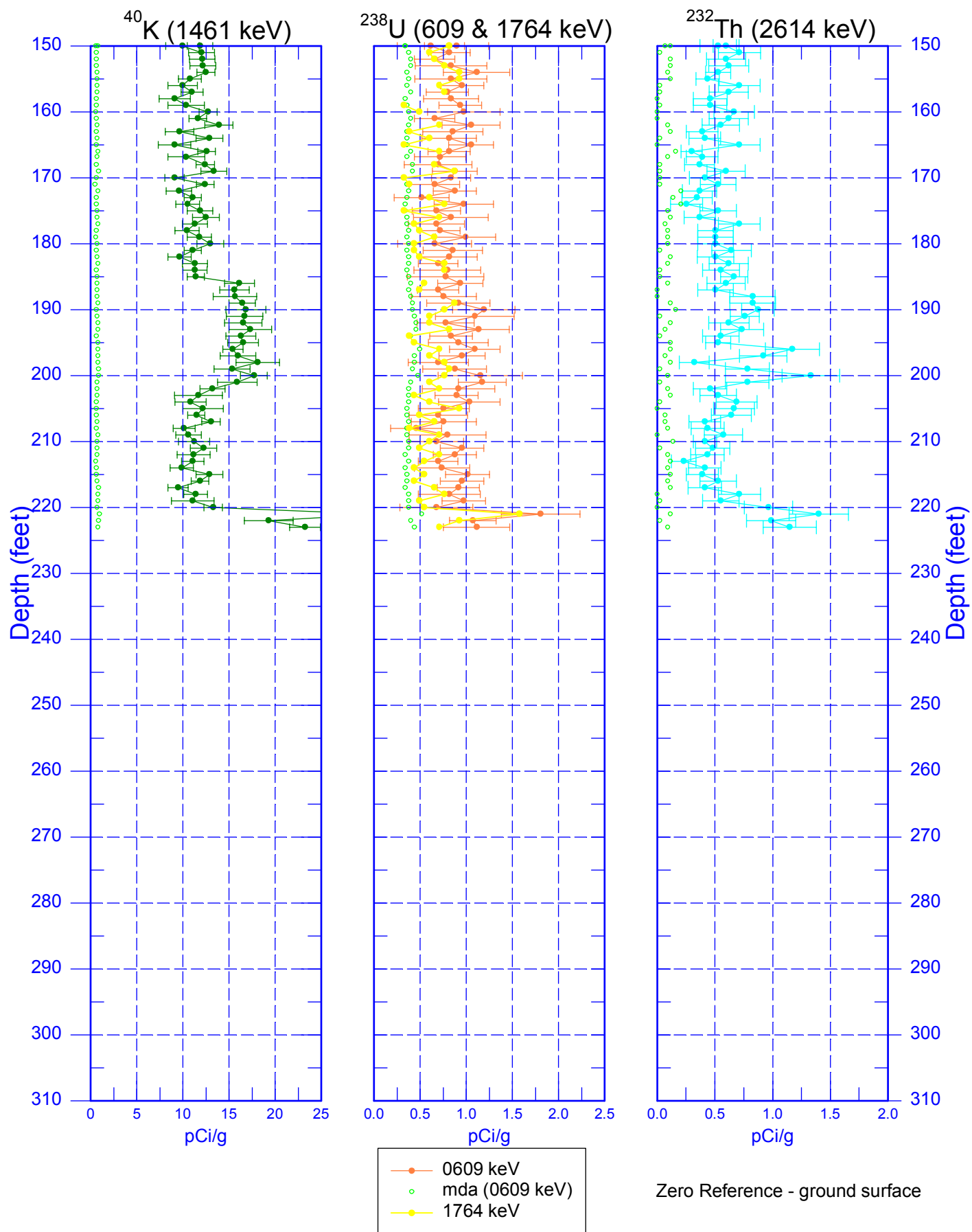
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Natural Gamma Logs

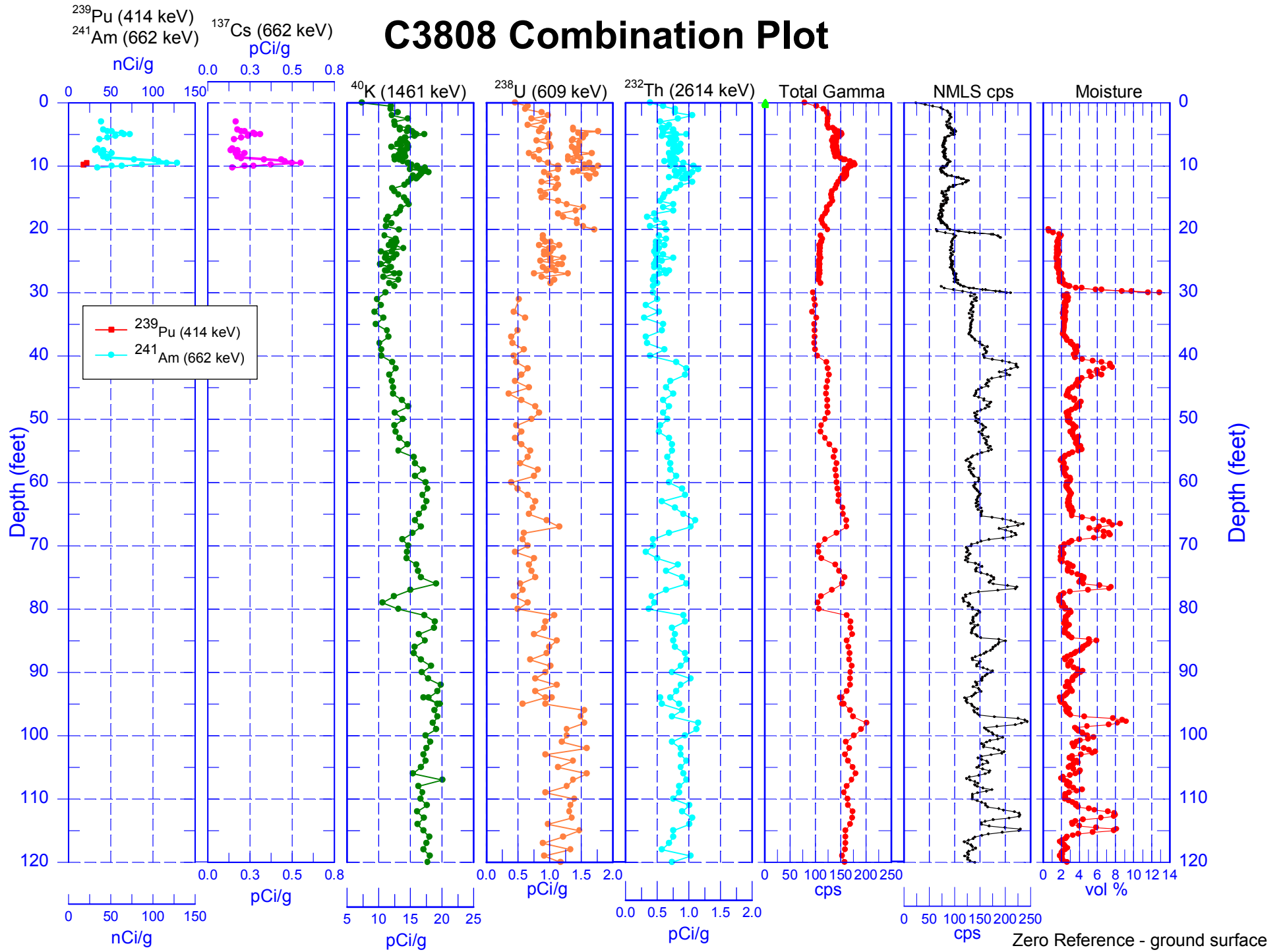


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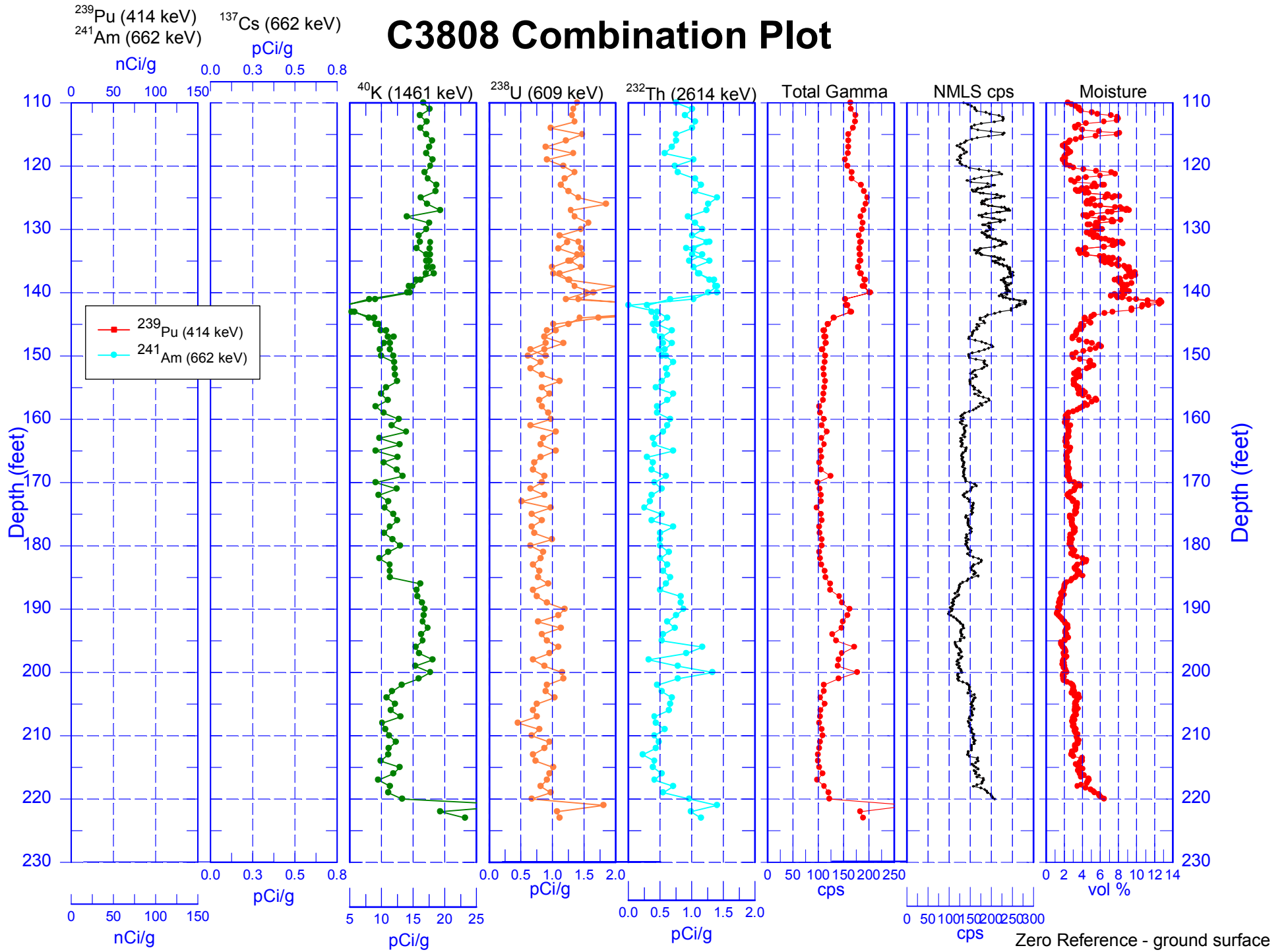
Natural Gamma Logs



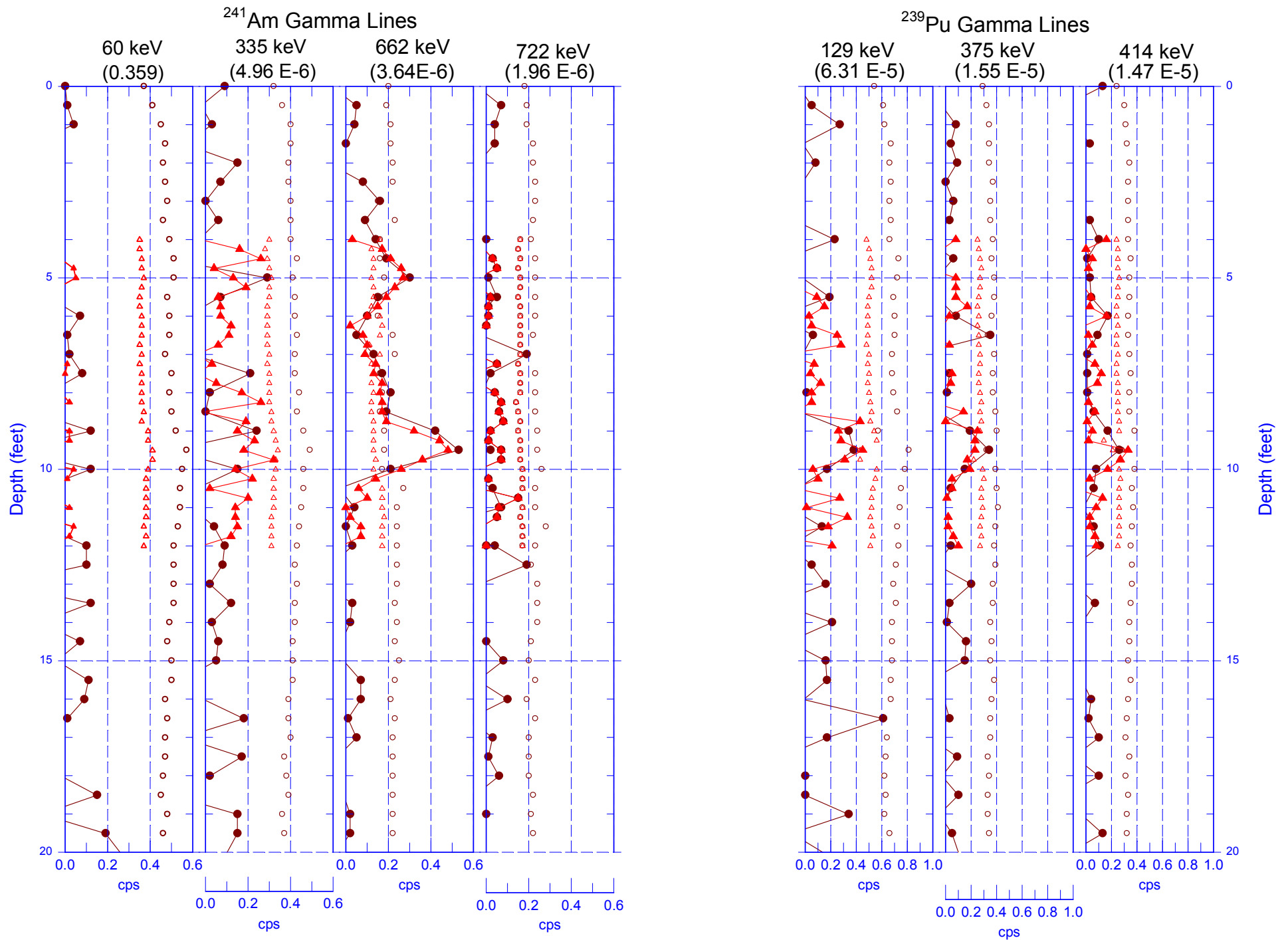
C3808 Combination Plot



C3808 Combination Plot

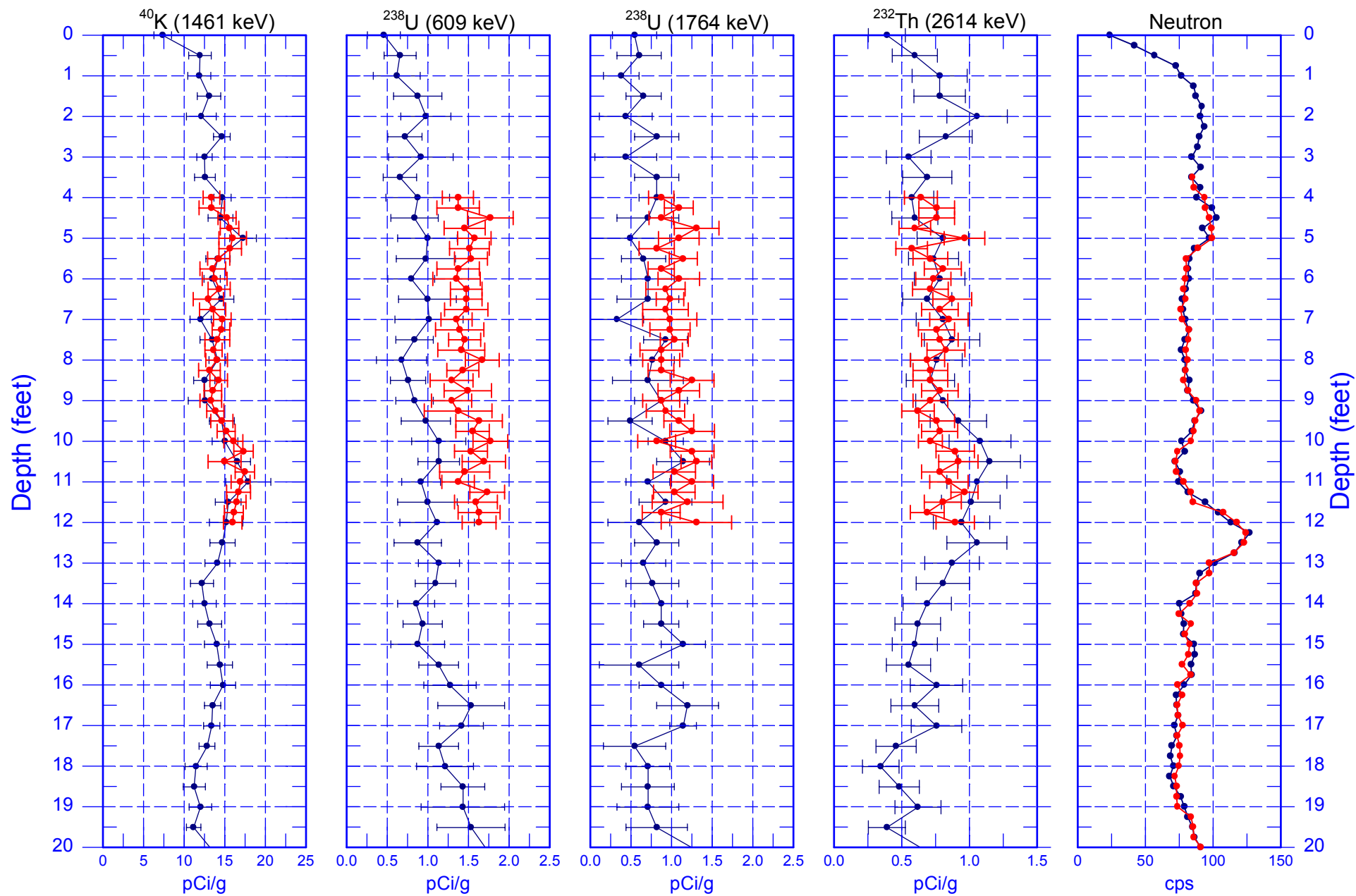


C3808 - Net Counts



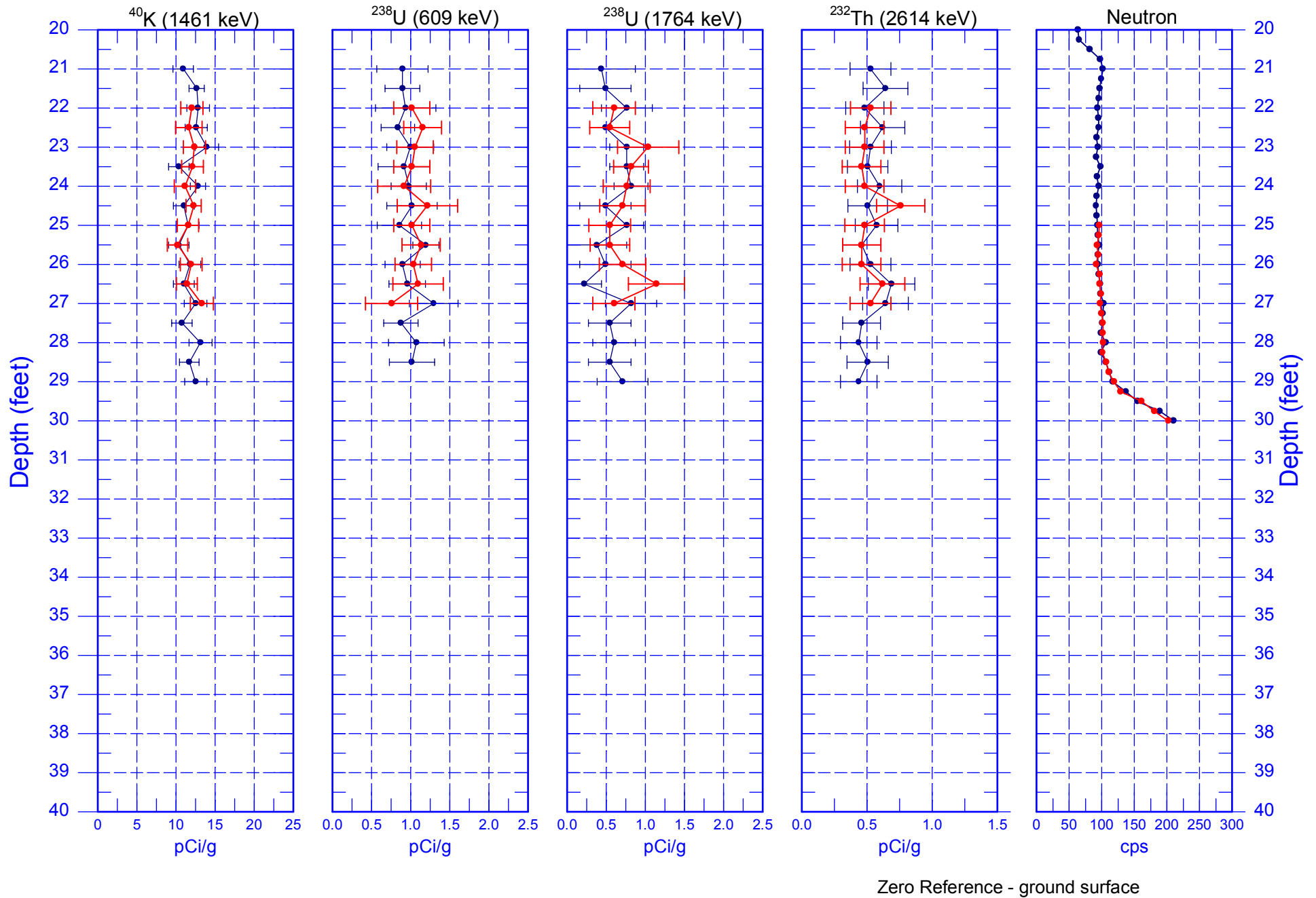
Zero Reference - ground surface

C3808 Repeat Logs

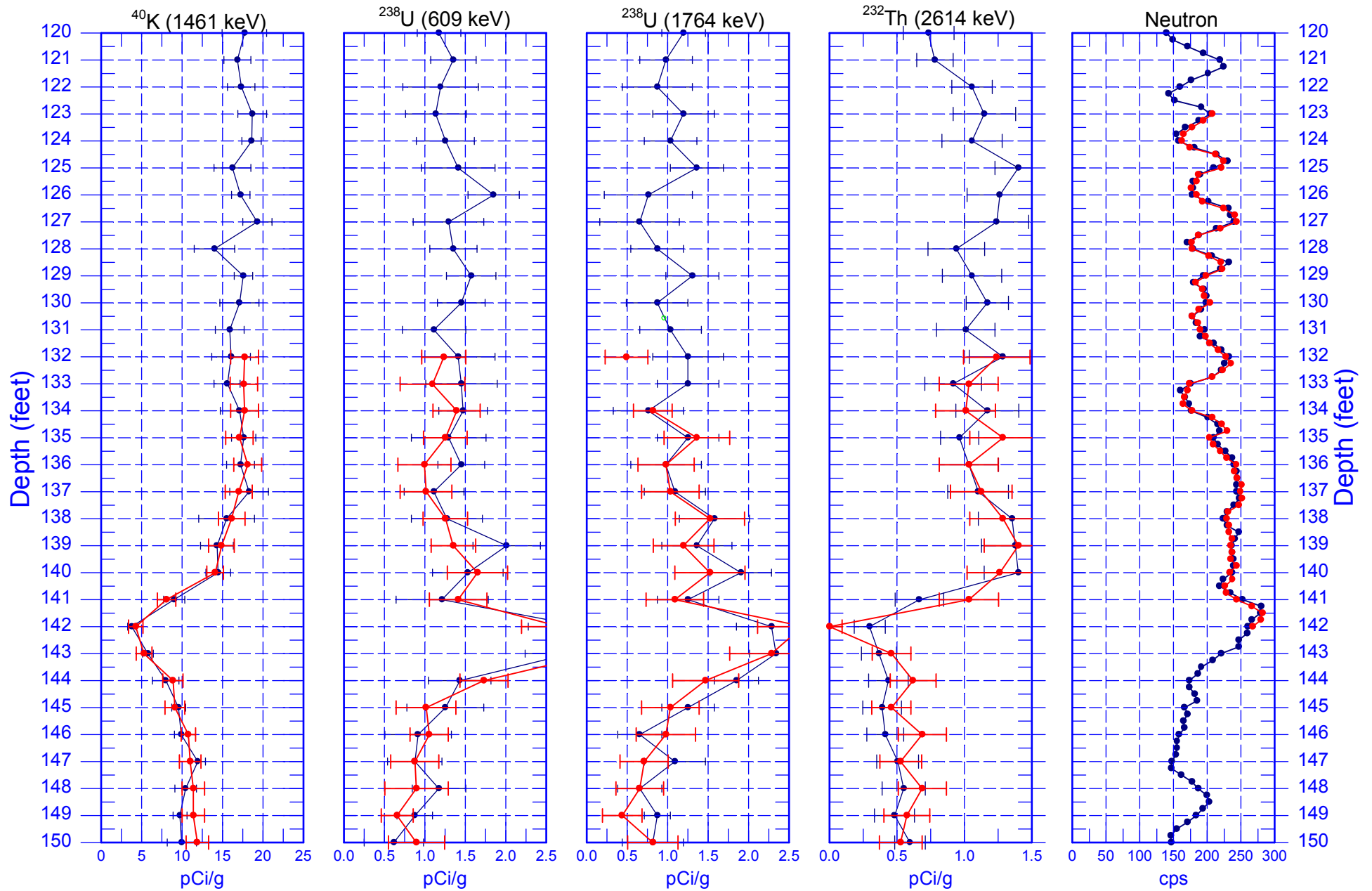


Zero Reference - ground surface

C3808 Repeat Logs



C3808 Repeat Logs



Zero Reference - ground surface